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Report
on
Holbrook Reservoir
Otero County
Colorado
EPA Region VIII
Working Paper No. 772

With the cooperation of the
Colorado Department of Health
and the
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July, 1977

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Colorado Department of Health for professional involvement, to the Colorado National Guard for conducting the tributary sampling phase of the Survey, and to those wastewater treatment plant operators who voluntarily provided effluent samples.

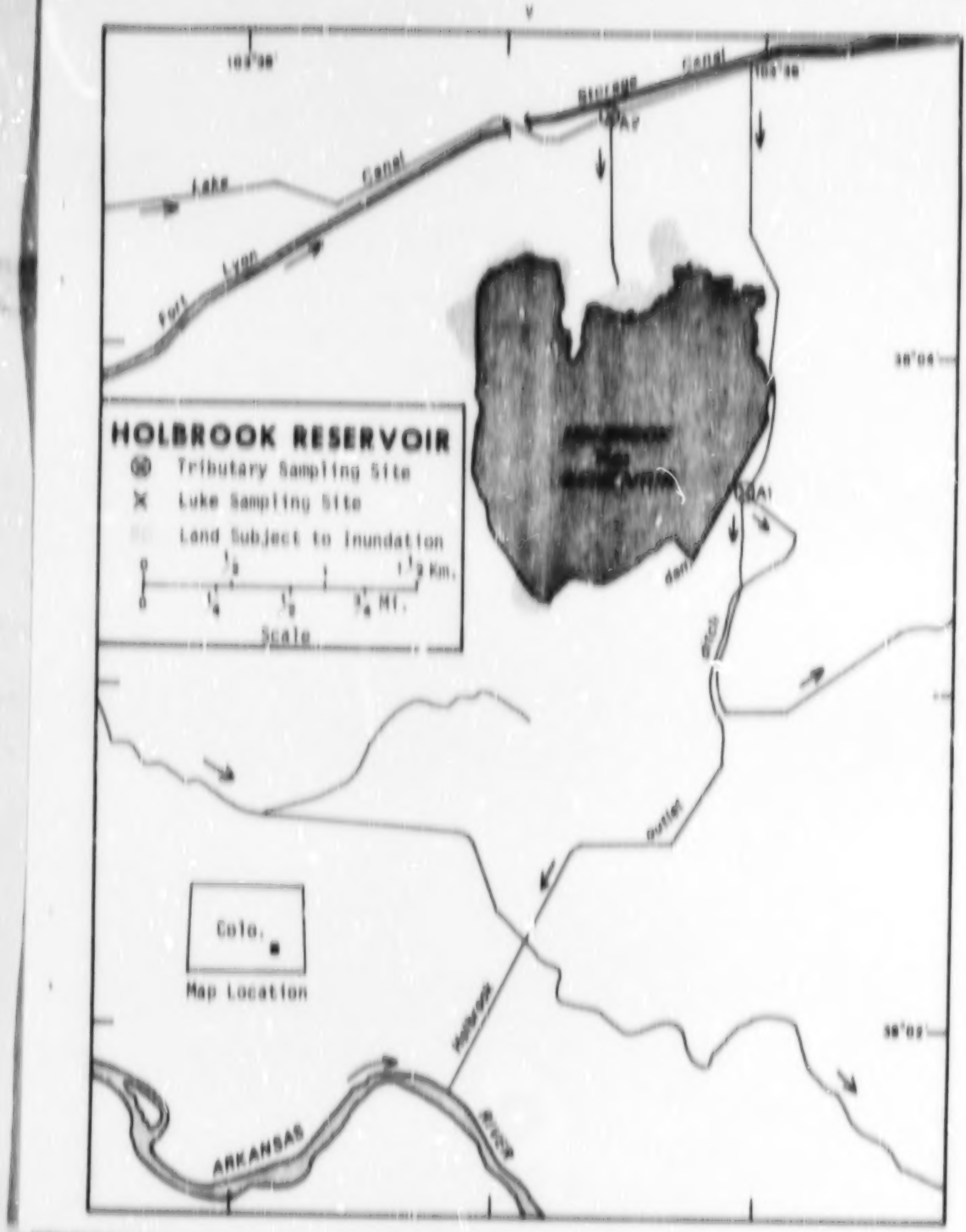
The staff of the Water Quality Control Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Lt. Colonel Paul A. Parsons, the Deputy Adjutant General of Colorado, and Project Officer Colonel Hershel C. Yeargan, who directed the volunteer efforts of the Colorado National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY
STUDY LAKES AND RESERVOIRS

STATE OF COLORADO

NAME	COUNTY
Barker	Boulder
Barr	Adams
Blue Mesa	Boulder
Cherry Creek	Arapahoe
Cucharas	Huerfano
Dillon	Summit
Grand	Grand
Green Mountain	Summit
Holbrook	Otero
Meredith	Crowley
Milton	Weld
Navajo	Archuleta, CO; San Juan, Rio Arriba, NM
Shadow Mountain	Grand


HOLBROOK RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Land Subject to Inundation
Scale
Km.
Mi.
Colo.
Map Location
Lake
Canal
Fort Lyon
Arkansas
dam
outlet

HOLBROOK RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Scale
ARKANSAS
RIVER
Colo.
Map Location
HOLBROOK RESERVOIR

HOLBROOK RESERVOIR

STORET NO. 0809

I. INTRODUCTION

Accurate flow data could not be provided for Holbrook Reservoir by the U.S. Geological Survey because water enters and leaves through ungaged inlet and outlet canals. Therefore, this report primarily pertains to the lake sampling data. However, results of analyses of tributary samples are presented in Appendix D.

II. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Holbrook Reservoir is eutrophic. It ranked ninth in overall trophic quality when the 13 Colorado lakes and reservoirs sampled in 1975 were compared using a combination of six parameters*. Nine of the water bodies has less median total phosphorus, nine had less median dissolved orthophosphorus, eight had less median inorganic nitrogen, 11 had less mean chlorophyll a, and all of the others had greater mean Secchi disc transparency.

Survey limnologists reported algal blooms in August and October and estimated that macrophytes occupied 30% of the shoreline shallows at those times.

B. Limiting Nutrient Study:

The results of the algal assay indicate that nitrogen was limiting at the time the sample was taken (05/06/75).

The reservoir data indicate nitrogen limitation in May and October and phosphorus limitation in August.

* See Appendix A.

III. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS[†]

A. Morphometry[††]:

1. Surface area: 2.72 kilometers^2.
2. Mean depth: 2.5 meters.
3. Maximum depth: 6.4 meters.
4. Volume: 6.908 x 10^6 m^3.

B. Precipitation*:

1. Year of sampling: 25.3 centimeters.
2. Mean annual: 31.8 centimeters.

† Table of metric conversions--Appendix B.
†† Anderson, 1974.
* See Working Paper No. 175, "...Survey Methods, 1973-1976".

IV. WATER QUALITY SUMMARY

Holbrook Reservoir was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, a near-surface sample for physical and chemical parameters was collected from one station on the reservoir (see map, page v). During each visit, a depth-integrated (near bottom to surface) sample was collected for phytoplankton identification and enumeration, and a similar sample was taken for chlorophyll a analysis. During the first visit, a single 18.9-liter depth-integrated sample was collected for algal assays.

The sampling results are presented in full in Appendix C and are summarized in the following table.

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B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
05/06/75	1. Oscillatoria sp.	35,005
	2. Synedra sp.	16,440
	3. Flagellates	6,083
	4. Stephanodiscus sp.	2,137
	5. Cryptomonas sp.	1,973
	Other genera	4,185
	Total	66,823
08/22/75	1. Anabaenopsis sp.	34,071
	2. Oscillatoria sp.	11,005
	3. Anabaena sp.	2,111
	4. Cryptomonas sp.	2,111
	5. Scenedesmus sp.	1,500
	Other genera	1,808
	Total	52,614
10/07/75	1. Anabaenopsis sp.	31,245
	2. Oscillatoria sp.	13,077
	3. Nitzschia sp.	2,467
	4. Cryptomonas sp.	2,595
	5. Stephanodiscus sp.	799
	Other genera	1,099
	Total	56,302

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
05/06/75	1	28.7
08/22/75	1	146.9
10/07/75	1	160.2

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.042	0.192	63.3
0.050 P	0.092	0.192	69.4
0.050 P + 1.0 N	0.092	1.192	96.0
1.0 N	0.042	1.192	93.1

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Holbrook Lake was extremely high at the time the algal assay sample was collected (05/06/76).

There was a significant increase in yield when only nitrogen was added, but no such response occurred when only phosphorus was added. Therefore, nitrogen limitation is indicated at that time.

The reservoir data indicate nitrogen limitation in May and October (the mean inorganic nitrogen to orthophosphorus ratios were 3 to 1 and 1 to 1, respectively). However, phosphorus limitation is indicated in August (the mean N/P ratio was 80/1).

V. MEAN NUTRIENT CONCENTRATIONS IN UNGAGED STREAMS

Tributary	Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
Outlet Ditch A-1	0.210	1.965
Ditch A-2	0.440	3.630

VI. LITERATURE REVIEWED

Anderson, R. Dennis, 1974. Personal communication (waterbody information and morphometry). CO Dept. of Health, Denver.

VII. APPENDICES

APPENDIX A

LAKE RANKINGS

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[redacted] RANKED BY [redacted] NO.

Rank	LAKE CODE	LAKE NAME	[redacted] NO.
1	[redacted]	[redacted]	521
2	[redacted]	[redacted]	474
3	[redacted]	[redacted]	452
4	[redacted]	[redacted]	433
5	[redacted]	[redacted]	369
6	[redacted]	[redacted]	354
7	[redacted]	[redacted]	296
8	[redacted]	[redacted]	281
9	[redacted]	[redacted]	263
10	[redacted]	[redacted]	262
11	[redacted]	[redacted]	257
12	[redacted]	[redacted]	254
13	[redacted]	[redacted]	85

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

PHYSICAL and CHEMICAL DATA

[illegible]

[illegible]

[illegible]

APPENDIX D

TRIBUTARY DATA